CERES FLASHFlux Status:

Near-Real Time Surface Radiative Fluxes and Meteorology for Research and Applications

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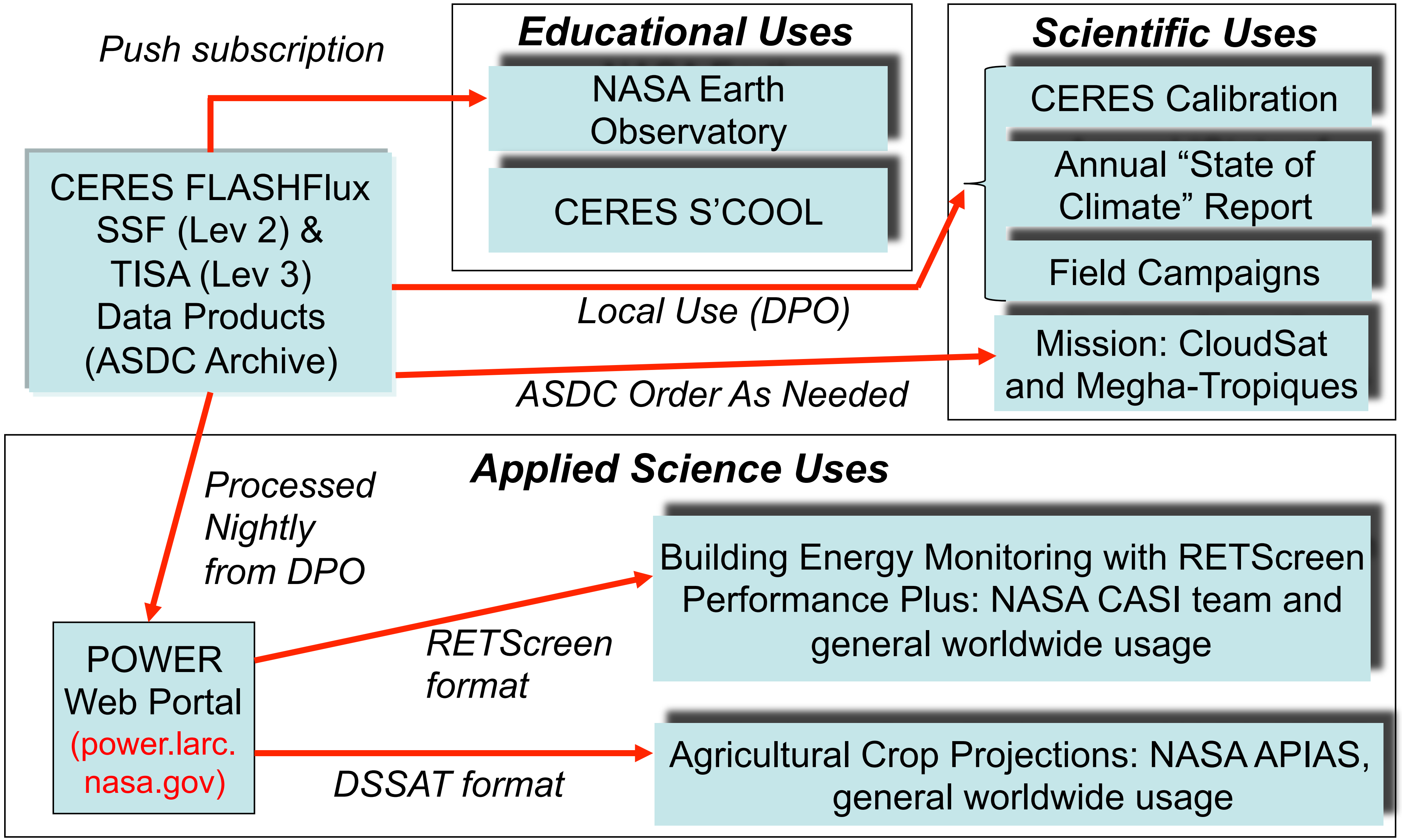
Jason Barnett, Booz-Allen-Hamilton

Tonya Davenport, Lindsay Parker and the Atmospheric Science Data Center Team (SSAI)

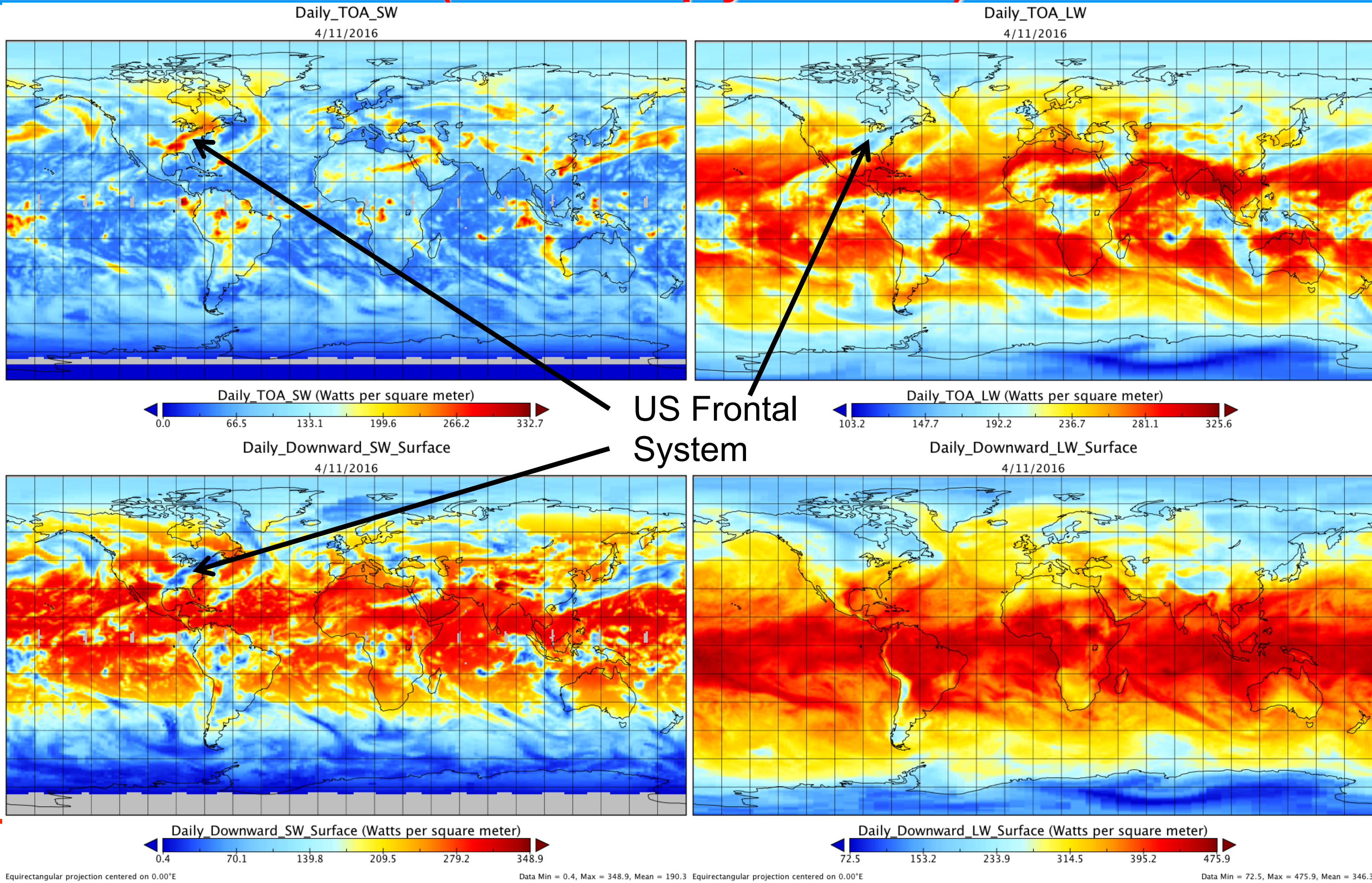
FLASHFLUX: Schematic of Current Uses



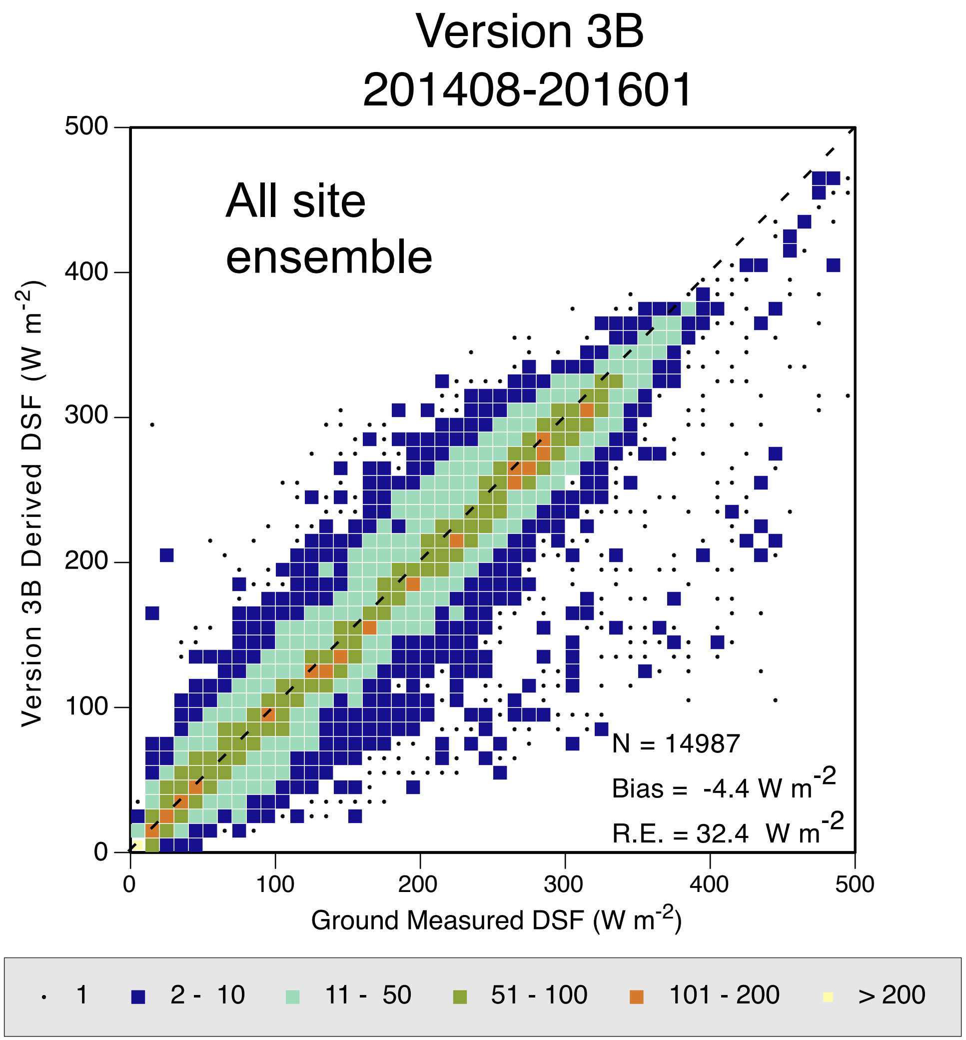
FLASHFlux Status

- ***Continuing production with v3B (since August 2014)***
  - FLASHFlux SSF available via CERES subsetter and ASDC through 8/28
  - FLASHFlux TISA available from ASDC and specialized formats through POWER web portal (power.larc.nasa.gov) through 8/26
  - TISA netCDF files production continued
  - **Big Issue: Terra safe mode data drop out from 2/18 – 2/25**
- ***Version 3B Validation***
  - Processed and compared to latest validation from BSRN, ARM & buoy
- ***Flux Anomalies from the 2015-2016 El Nino***
  - "State of Climate 2015" submitted
  - Differences between July 2015 and July 2013
- ***Applied Science Usage: Expansion to GIS***
  - Agricultural and Energy usage showed continued growth since May (1100+ users, 400,000+ orders per, 21+ GB per month)
  - First efforts to serve CERES using GIS tools for FLASHFlux and SYN1Deg

FLASHFlux .netCDF Format
(from Panoply – 4/11/16)



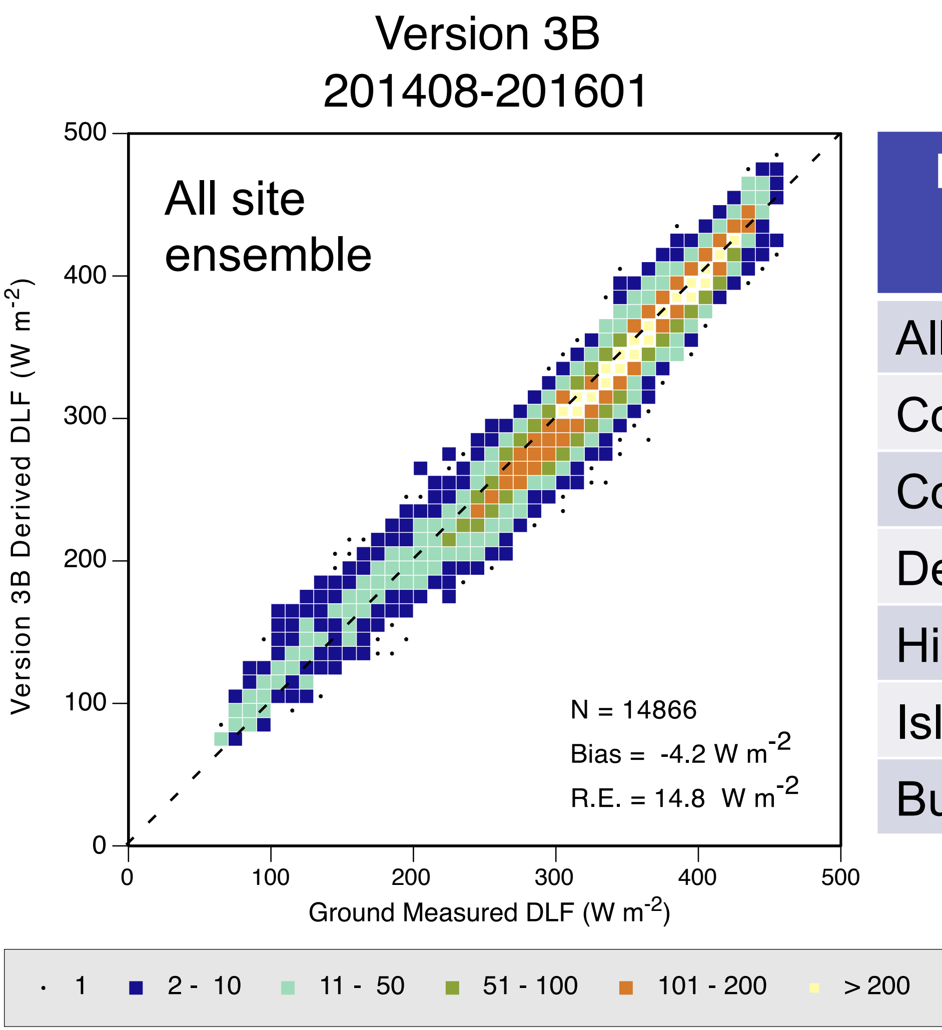
Recent SW Validation: 8/2014 – 1/2016



Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-4.4	34.0	14987
Continental	-2.5	25.7	5525
Coastal	-2.6	23.8	4464
Desert	-3.6	22.2	1518
High Latitude	-56.6	95.0	892
Island	2.3	26.5	916
Buoy	8.2	31.6	1672

Recent LW Validation: 8/2014 –1/2016

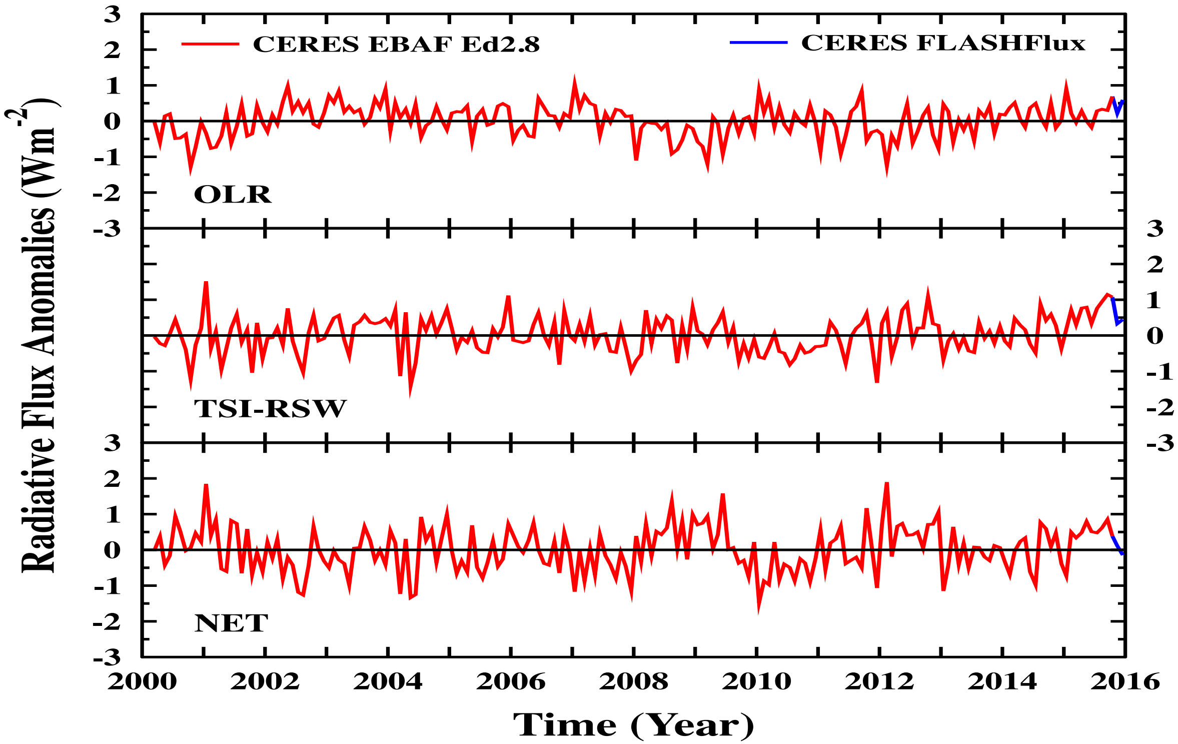


Daily Averaged TISA Comparison

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	-4.2	15.4	14866
Continental	-9.4	17.4	5310
Coastal	-1.8	11.8	4468
Desert	-2.4	15.6	1491
High Latitude	5.8	20.4	1309
Island	-1.5	9.9	860
Buoy	-5.0	13.7	1428

State of Climate 2015: Global TOA Fluxes

Monthly averaged FLASHFlux normalized and appended to EBAF



Annual averaged flux anomalies for 2015, relative to 2014, 2013 and EBAF climatology

	Global-annual Mean Difference (2015 minus 2013) (Wm^{-2})	Global-annual Mean Difference (2015 minus 2014) (Wm^{-2})	2015 Anomaly (relative to climatology) (Wm^{-2})	Interannual variability (2001 to 2014) (Wm^{-2})
OLR	+0.30	+0.15	+0.30	±0.50
TSI	+0.05	+0.05	+0.10	±0.20
RSW	−0.75	−0.45	−0.55	±0.40
Net	+0.50	+0.40	+0.35	±0.65

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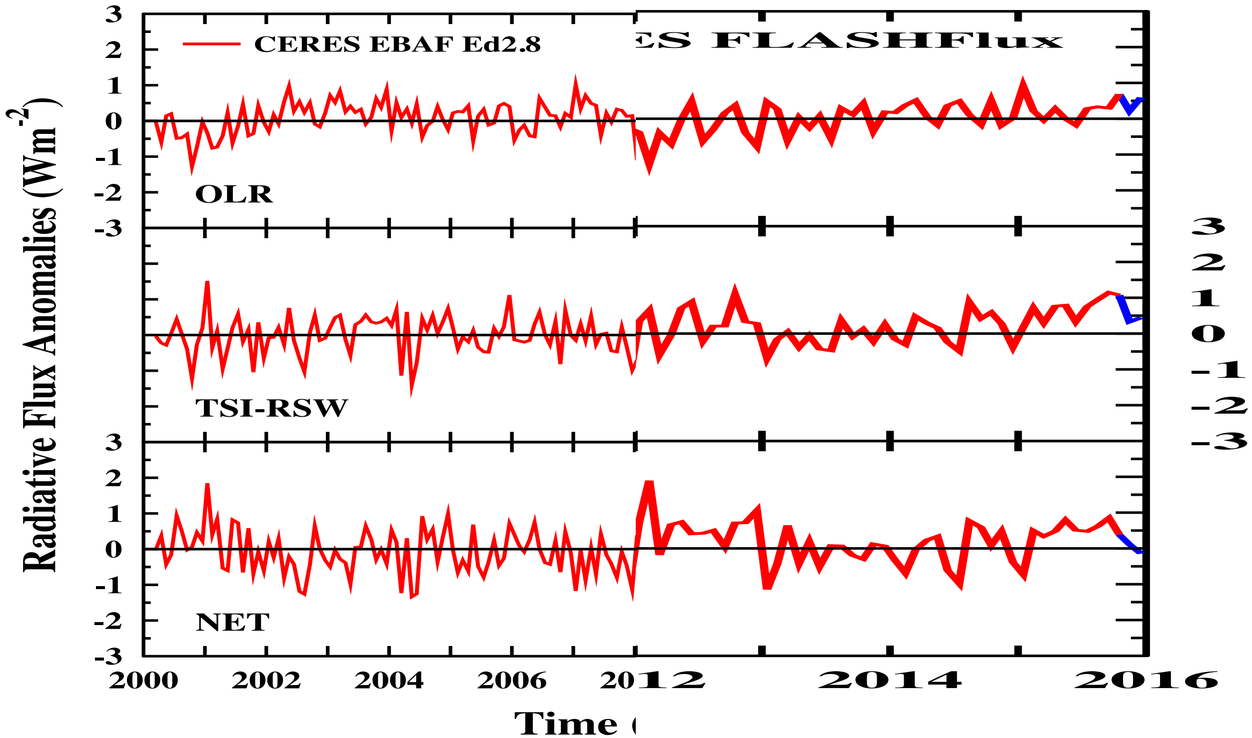

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State of Climate 2015: Surface Ocean Fluxes

Yu, Lisan *et al.*, 2016: Ocean surface and momentum fluxes [in "State of the Climate in 2015" In Press].

WHOI OAflux Latent & Sensible Heat fluxes + CERES FLASHFlux year-to-year difference for radiative fluxes

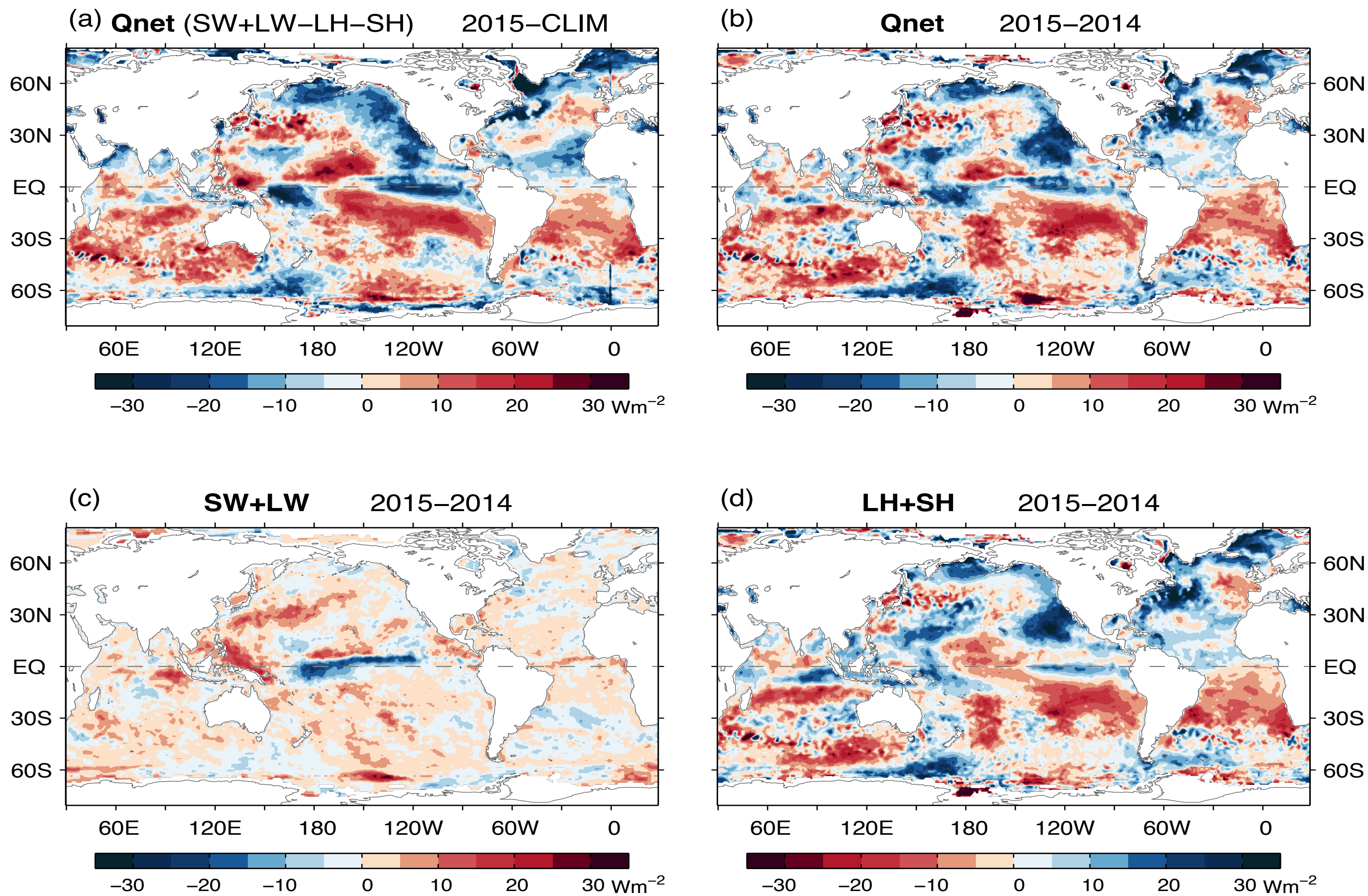
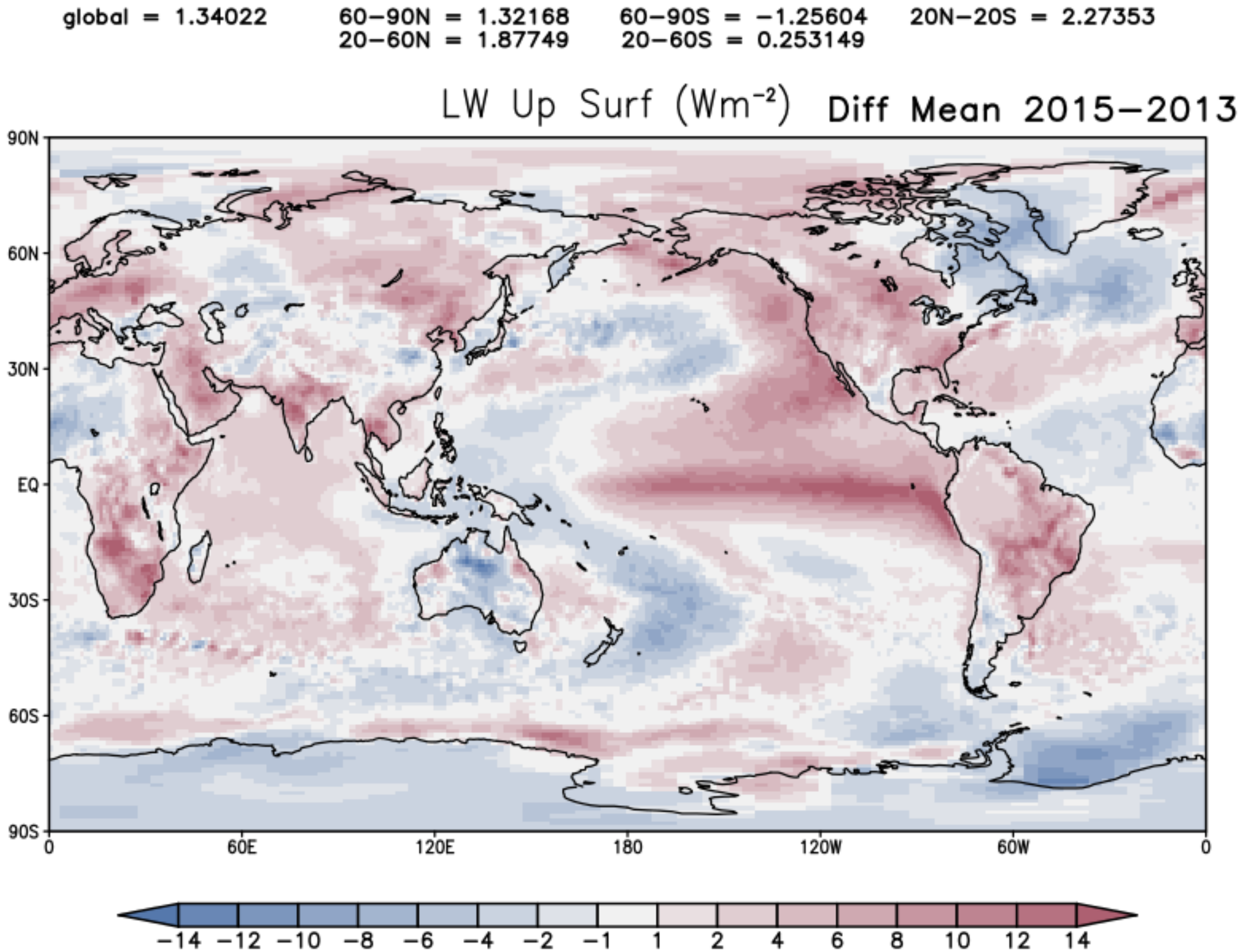
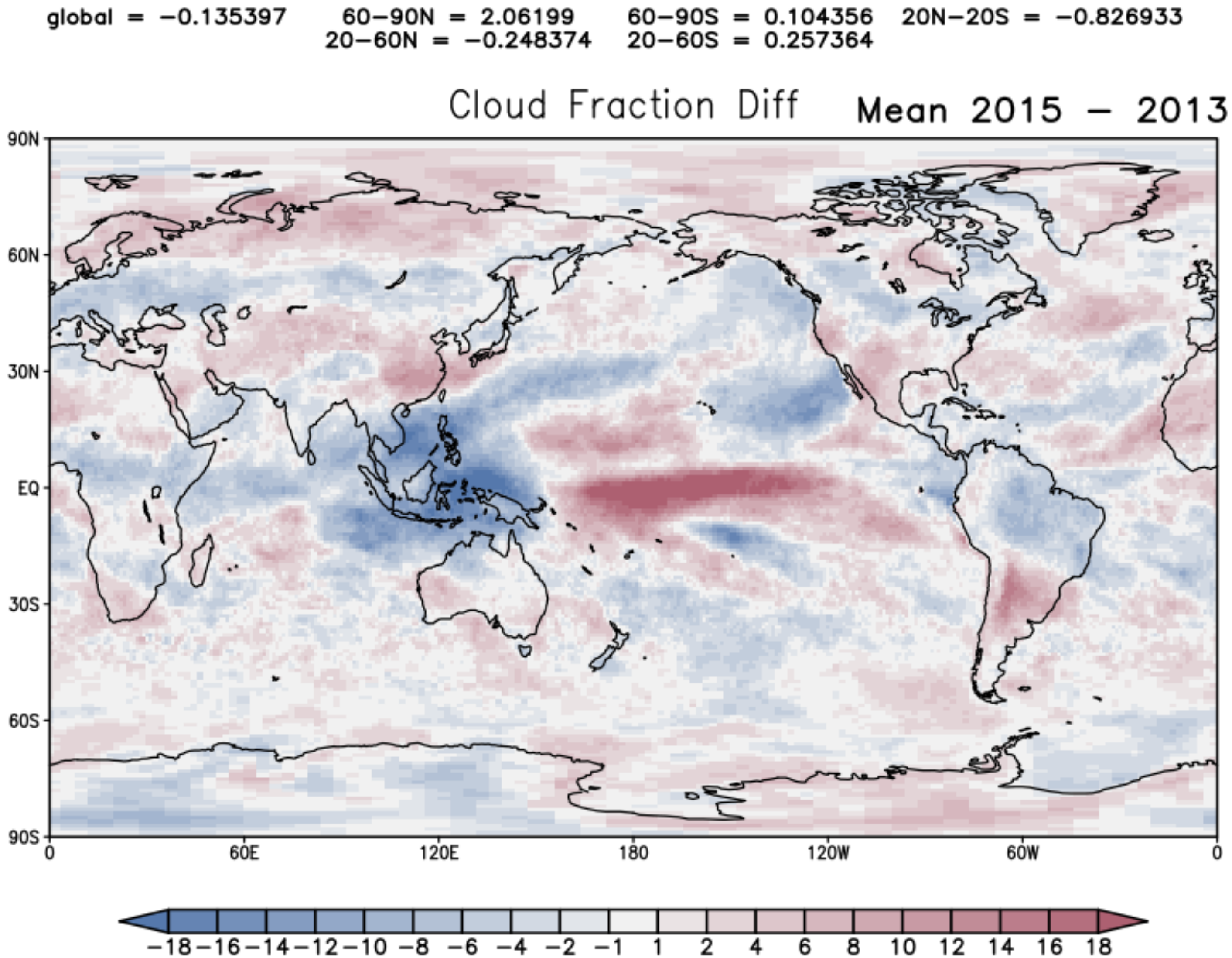


Figure 1.(a) The 2015 surface heat flux (Qnet) anomalies relative to the 5-year (2010-2014) mean. Positive (negative) values denote ocean heat gain (loss). (b), (c), and (d) are the 2015-2014 difference anomalies in Qnet, surface radiation (SW+LW, and turbulent heat fluxes (LH + SH), respectively. Positive (negative) anomalies denote that the ocean gains (loses) more heat in 2015 than in 2014. LH+SH are produced by the OAFlux high resolution satellite-based analysis and SW+LW by the NASA FLASHFlux project.

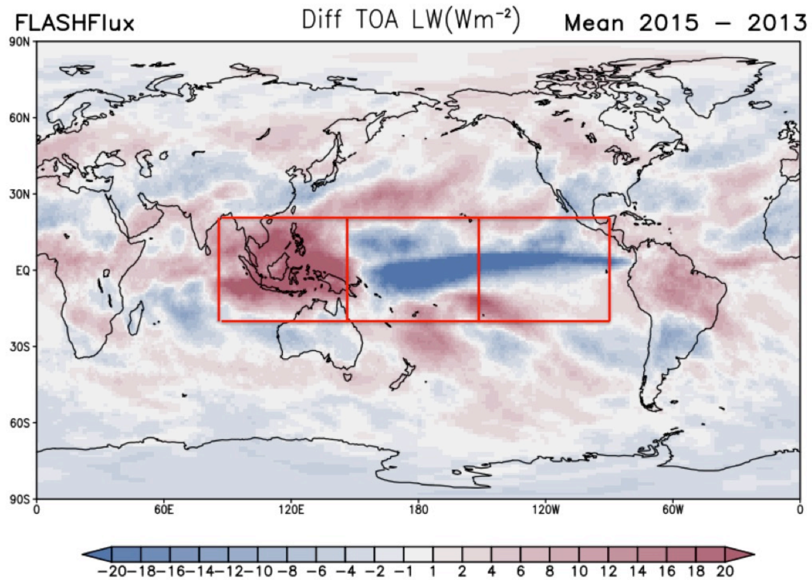
2015 El Nino: 2015 - 2013

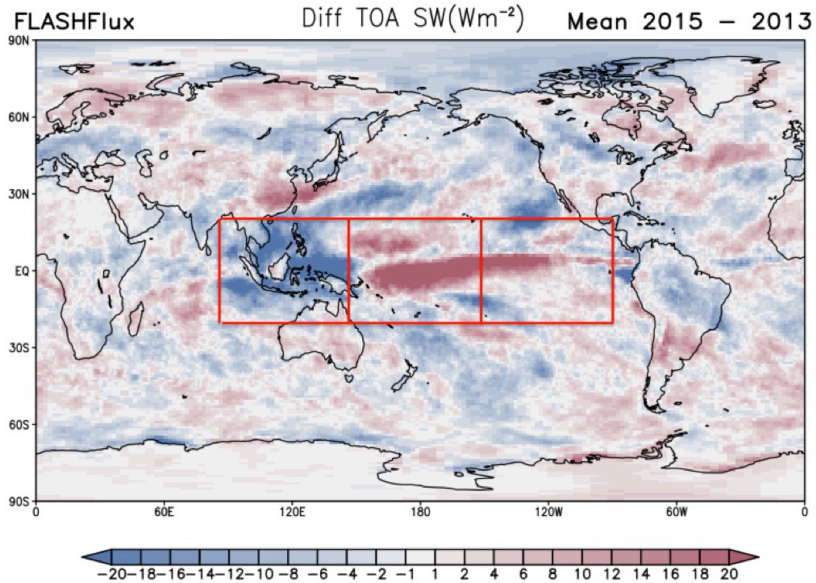


2015 El Nino: 2015 - 2013

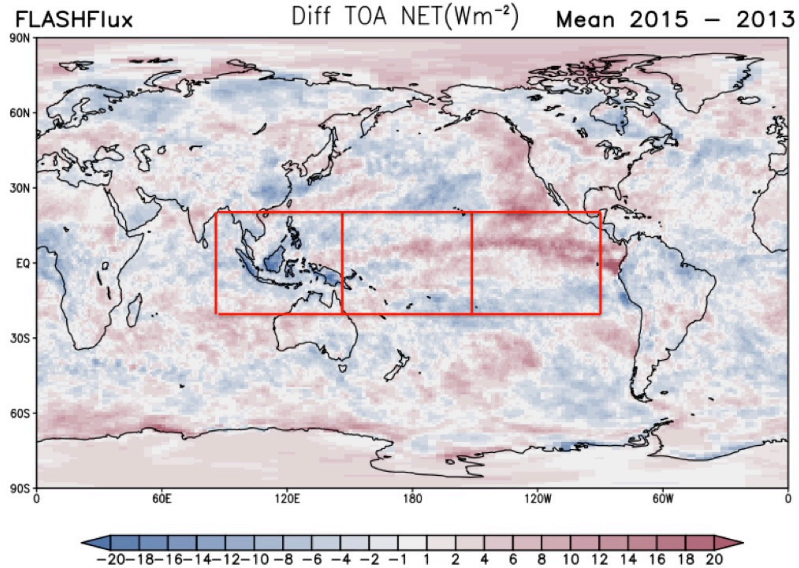


2015 El Nino: TOA 2015 - 2013

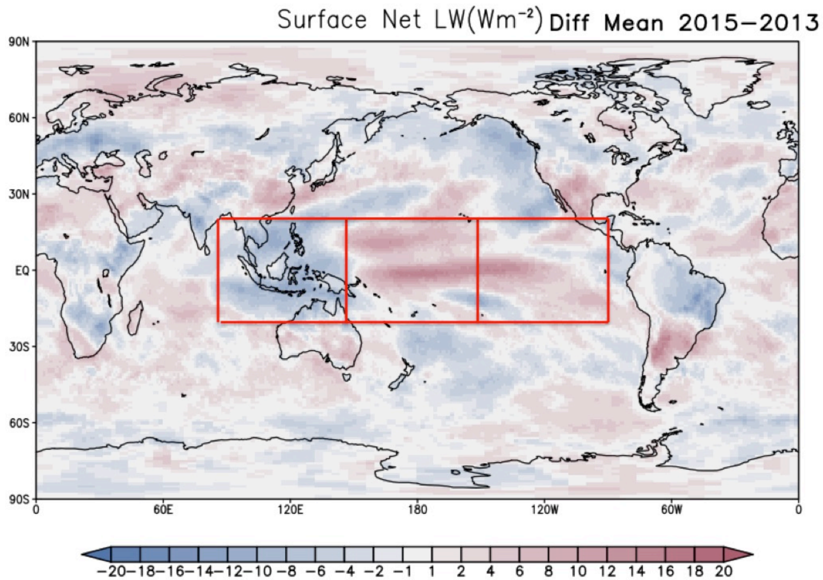


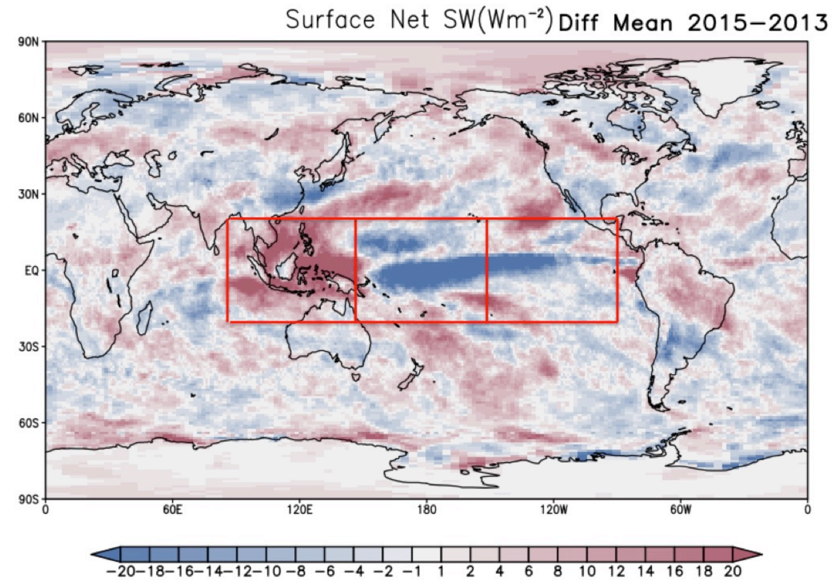


Near total SW/LW cancellation over W. Pacific, but strong positive net difference in E. Pacific and up W. coast of US.

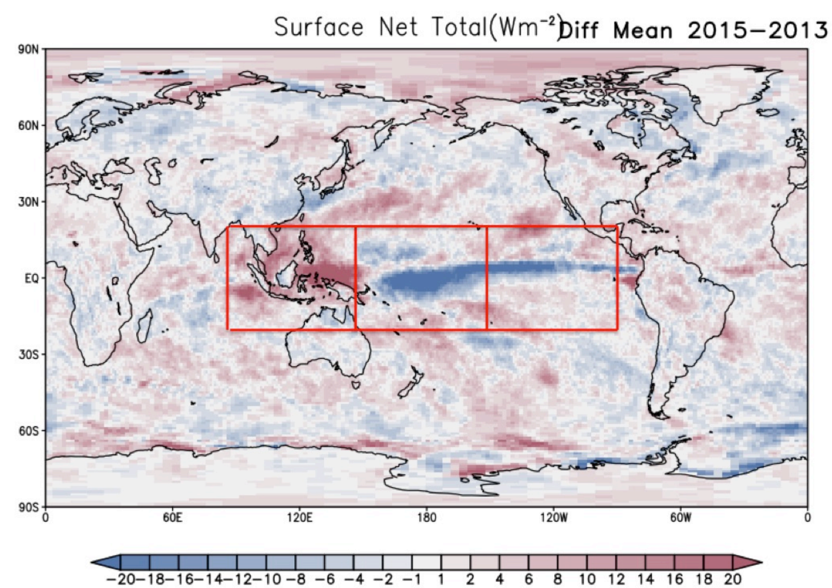


2015 El Nino: Surface 2015 - 2013

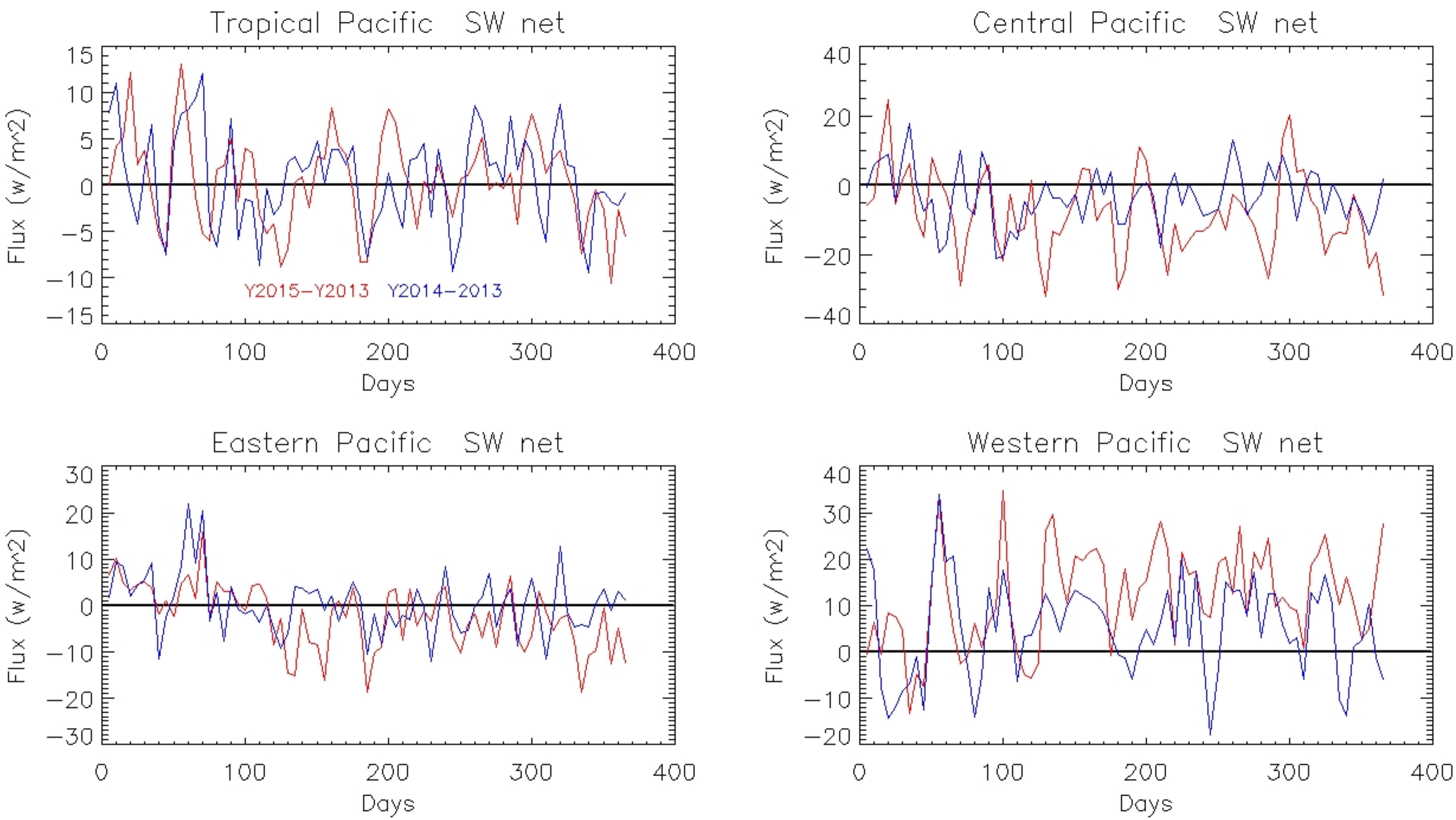




At surface, some partial SW/ LW cancellation in each region, but SW change appears to dominate; note .

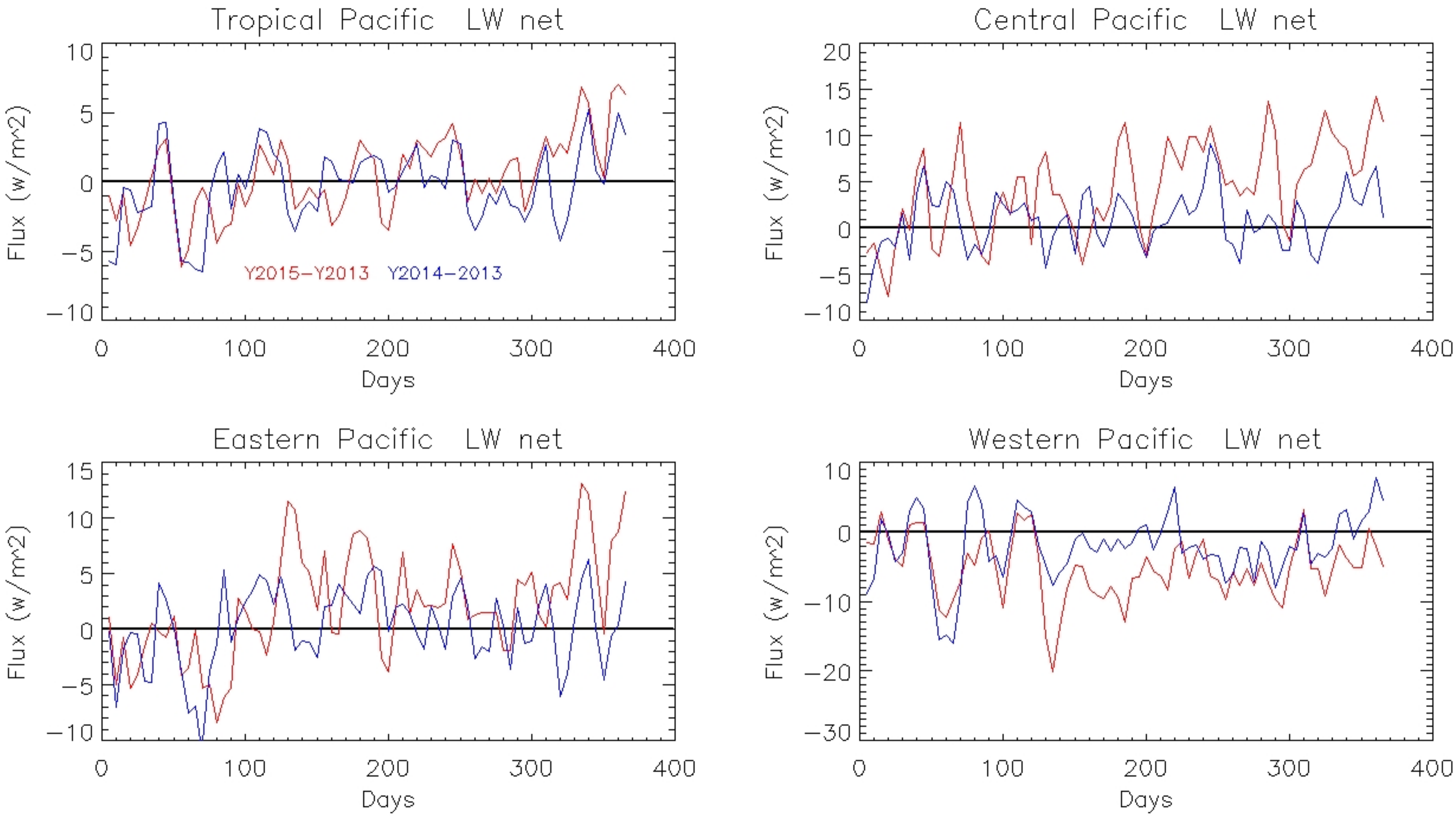


Tropical Surface Net SW Flux Changes

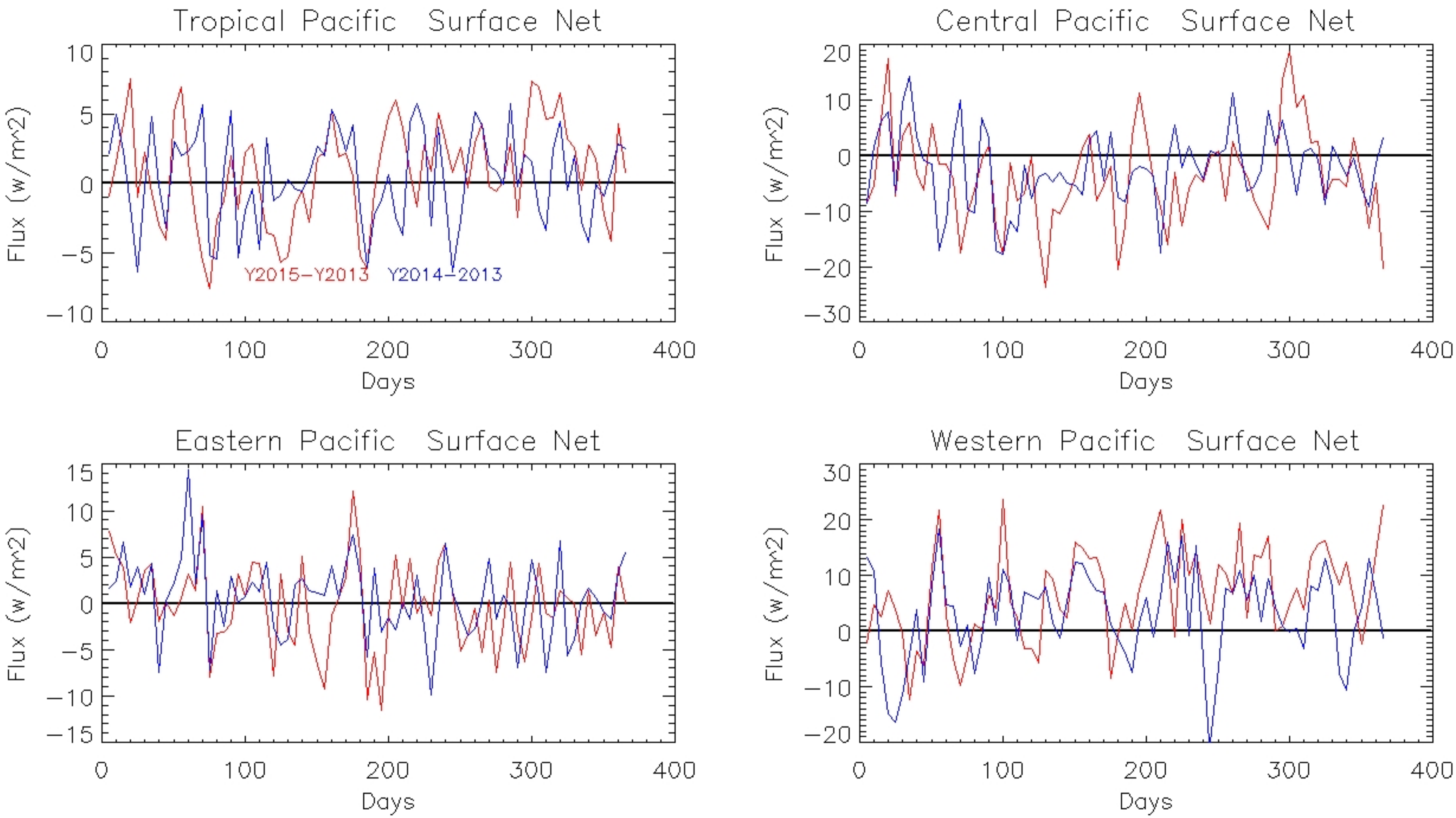


Tropical Surface Net LW Flux Changes

Positive change means LW net is less negative



Tropical Surface Total Net Flux Changes



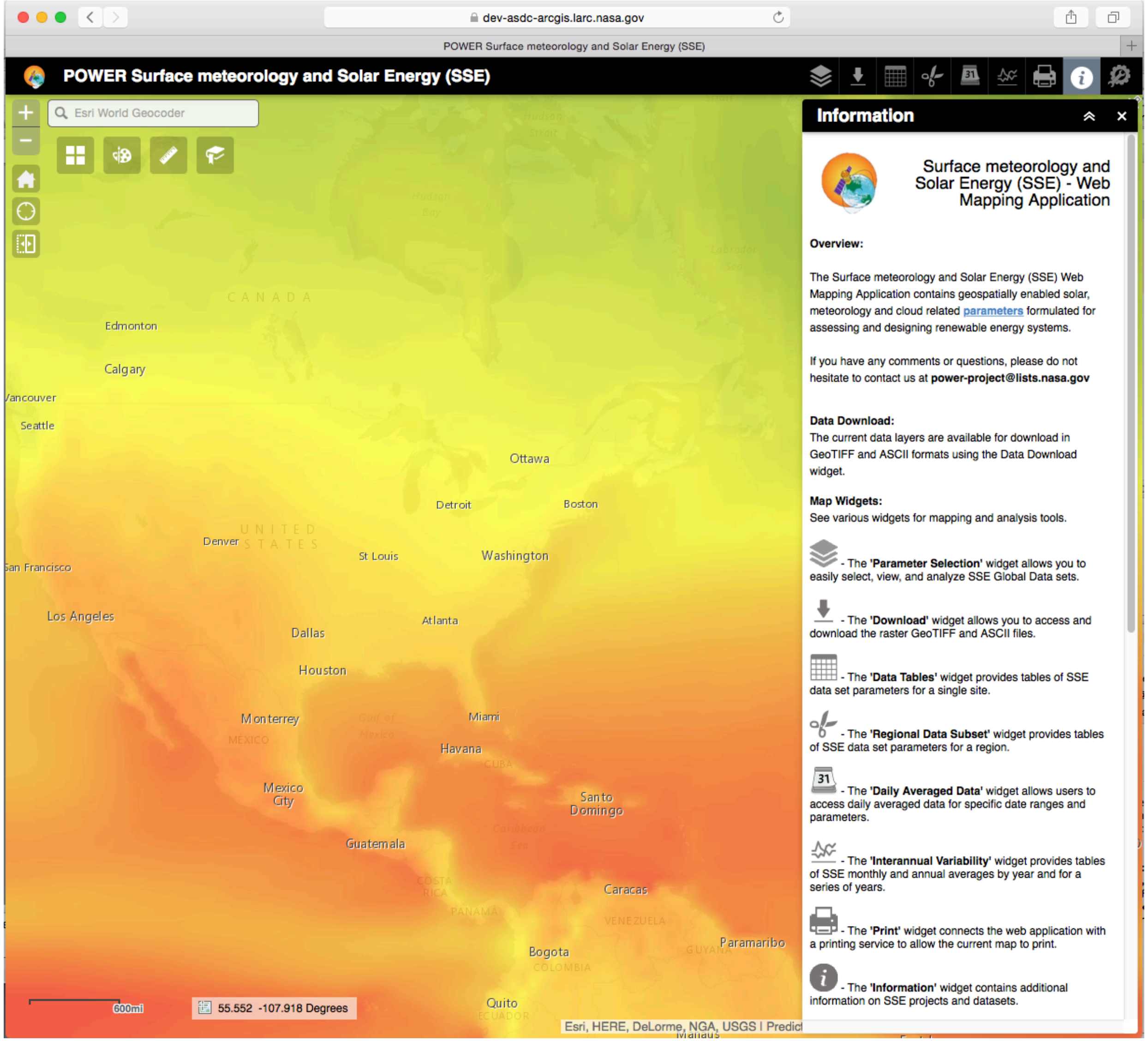
Using ArcGIS To Enhance Applied Science Usage of Data Products

GEOPLATFORM.gov

DATA.GOV

SSE-GIS Beta v1.0.3

- Nearing public release of SSE-GIS
- Provides users an opportunity interact with time series data sets of energy related data sets using web based GIS services from ESRI
- Services are hosted from ASDC servers
- Users can display maps, work with multiple layers, obtain data tables and geotiff files of the parameters



Progress Toward CERES GIS Support

- Published four CERES SYN1DEG ArcGIS Image Services in ***the development environment***. Allows users to 1) access the data via a REST endpoint/protocols, via JSON REST response, 2) utilize online web mapping application development tools via the ArcGIS API for JavaScript, 3) consume the services directly into ArcGIS Desktop and custom applications for further visualization and analysis.
- Data served directly from the CERES SYN1Deg Native NetCDFs:
  - SFC COMP LW DOWN ALL DAILY
  - SFC COMP SW DOWN ALL DAILY
  - SFC COMP SW DOWN CLR DAILY
  - TOA COMP SW DOWN ALL DAILY
- The 2 systems purchased by CERES have had systems software installed and are integrated into the WebRA production environment. Each server has 2 Intel Xeon E5-2643 v3 Processors (20M cache, 3.40 Ghz, 6 cores), 2.4TB of storage, 256 GB RAM (DDR4-2133MHz).
- A process was developed for integrating the machines into the production architecture for dedicated hosting of geospatial web services for CERES data products.
- These systems will be added to the ArcGIS cluster for dedicated hosting of CERES data product geospatial web services.

Progress Toward CERES GIS Support

Folder: ceres

https://dev-asdc-arcgis.larc.nasa.gov/server/rest/services/ceres

ArcGIS REST Services Directory

Home > services > ceres

JSON | SOAP

Published CERES SYN1DEG Image Servi
In Development Environment

Folder: ceres

Current Version: 10.4

View Footprints In: ArcGIS Online map viewer

Services:

- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_lw_down_all_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_sw_down_all_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_sw_down_clr_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_toa_comp_sw_down_all_daily (ImageServer)

Supported Interfaces: REST SOAP Sitemap Geo Sitemap

Progress Toward CERES GIS Support

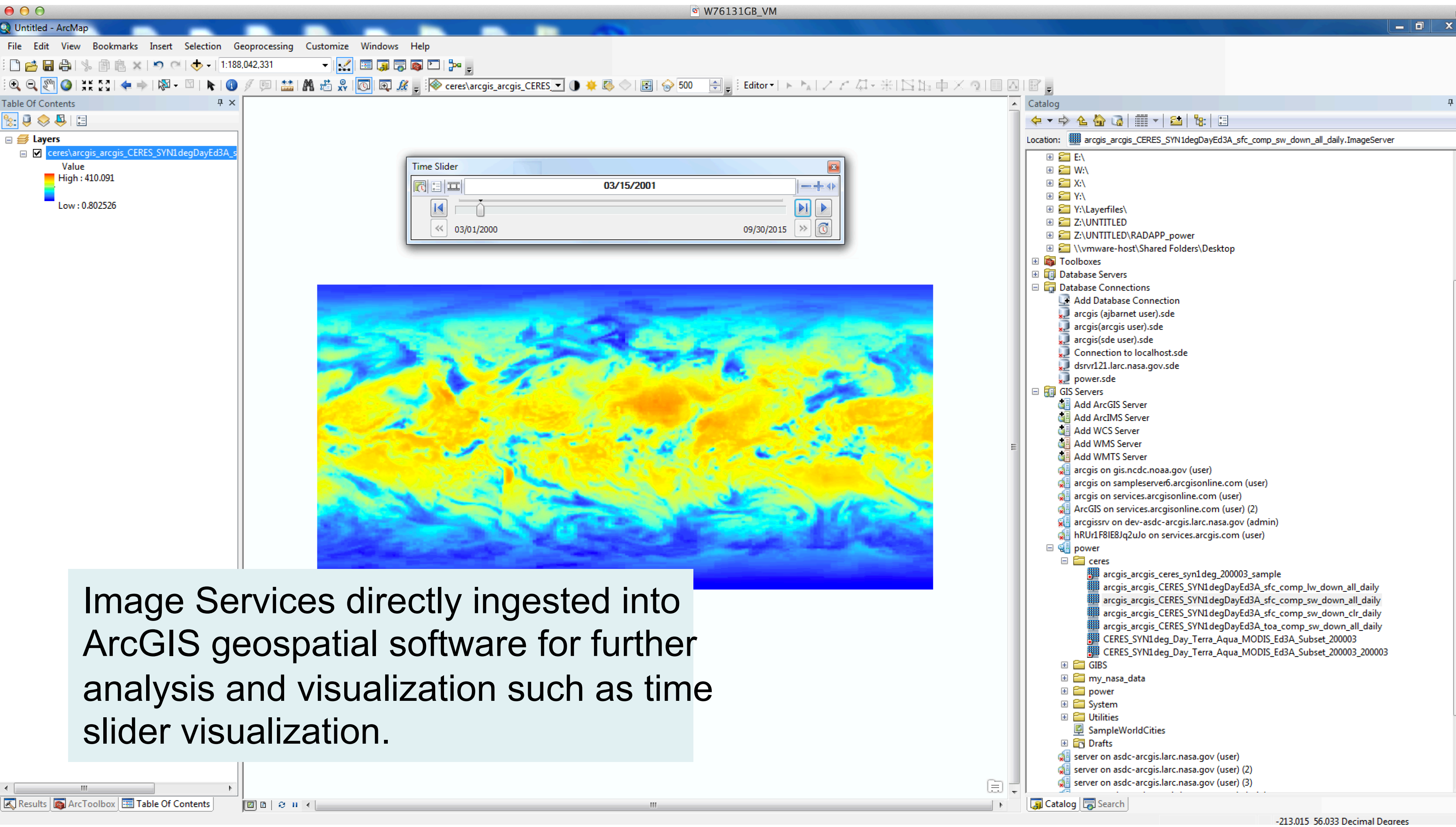


Image Services directly ingested into ArcGIS geospatial software for further analysis and visualization such as time slider visualization.

Future Plans

- Reprocess Terra gap period to evaluate Aqua only fluxes => current FLASHFlux TISA code cannot run without at least some of both Terra and Aqua
- FLASHFlux TISA netCDF to be made compliant => add to CERES subsetter
- Meteorological input migration from GEOS 5.9.1 to 5.12.4 => the replacement of FP-IT
- Upgrade CERES Ed 4 underway
- Begin work on NPP FLASHFlux SSF
- Planning for loss of Terra: began strategy to process and use GEO data for FLASHFlux production; will ensure more consistency between FF and TSI

Summary and Conclusions

- ***FLASHFlux 3B***
  - Continuing production and validation for v3B; surface site
  - Working to add TISA products to CERES subsetter
  - 2015 El Nino anomalies proving very significant
- ***FLASHFlux Applications:***
  - Continued growth of usage of FLASHFlux through POWER project
  - Developing GIS tools for CERES/POWER and with ASDC
- ***FLASHFlux publications:***
  - 2015 SotC reports submitted
  - TISA paper next (renewable energy journal?)
- ***Future Versions***
  - Must adapt MOA to accept FP-IT (GEOS 5.12.4)
  - Will coordinate with Clouds and Inversion teams to adapt to Ed 4
  - Begin work on NPP SSF production system as new modules arrive

FLASHFlux Web Sites:

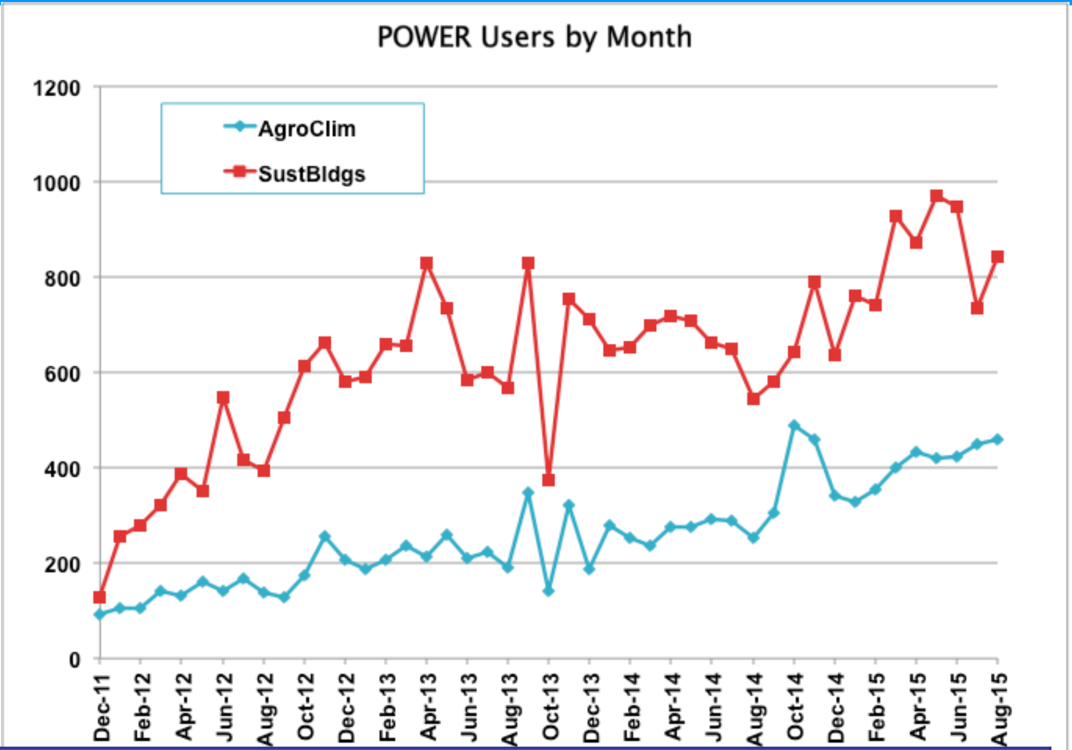
http://flashflux.larc.nasa.gov

Extras

Applied Science Usage

POWER makes ASCII time series data from FLASHFlux and FP-IT available for:

1) "Sustainable Building" => energy performance modeling
2) "Agroclimatology" => data format according to DSSAT crop modeling format



Average Usage Per Month

Type	Monthly Users	Monthly Orders	Monthly Data Vol (GB)
Sustainable Buildings	788	275,600	5.6
Agroclimatology	405	128,600	15.7
Total	**1192**	**404,200**	**21.3**

State of Climate 2014 Results

Wong et al., 2015: Earth Radiation Budget [in "State of the Climate in 2014"]. *BAMS*, 96 (7), S37-S38.

Year-to-year global changes 2014 vs. 2013

Table 2.6. Global-annual mean TOA radiative flux changes between 2013 and 2014, the 2014 global-annual mean radiative flux anomalies relative to their corresponding 2001–13 mean climatological values, and the 2-σ interannual variabilities of the 2001–13 global-annual mean fluxes (all units in W m^{-2}) for the outgoing longwave radiation (OLR), total solar irradiance (TSI), reflected shortwave (RSW) and total net fluxes. All flux values have been rounded to the nearest 0.05 W m^{-2}.

	One year change (2014 minus 2013) (W m^{-2})	2014 anomaly (relative to climatology) (W m^{-2})	Interannual variability (2001–13) (W m^{-2})
OLR	+0.15	+0.15	±0.50
TSI	−0.05	+0.05	±0.20
RSW	−0.45	−0.25	±0.40
Net	**+0.25**	**+0.15**	**±0.65**

Global-monthly average flux anomalies

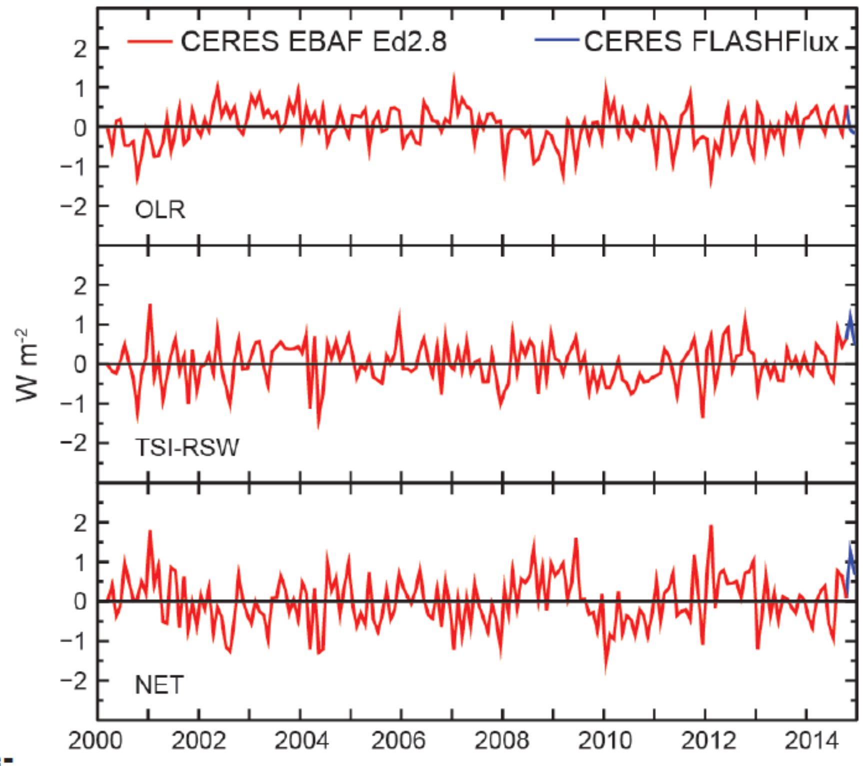
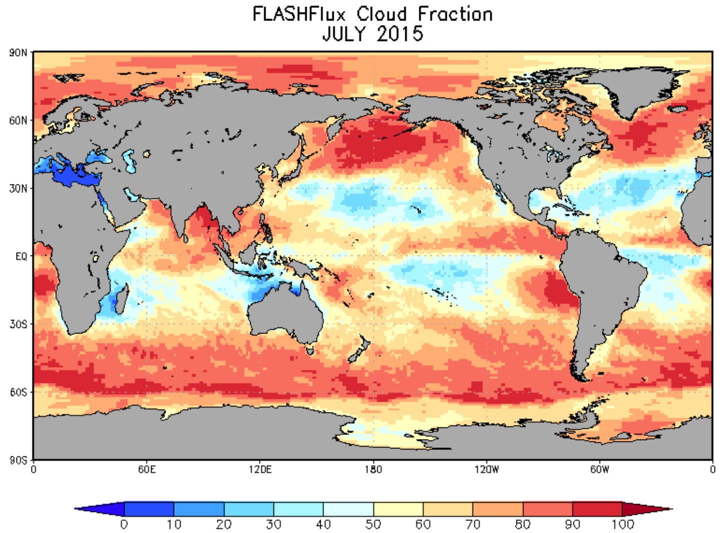
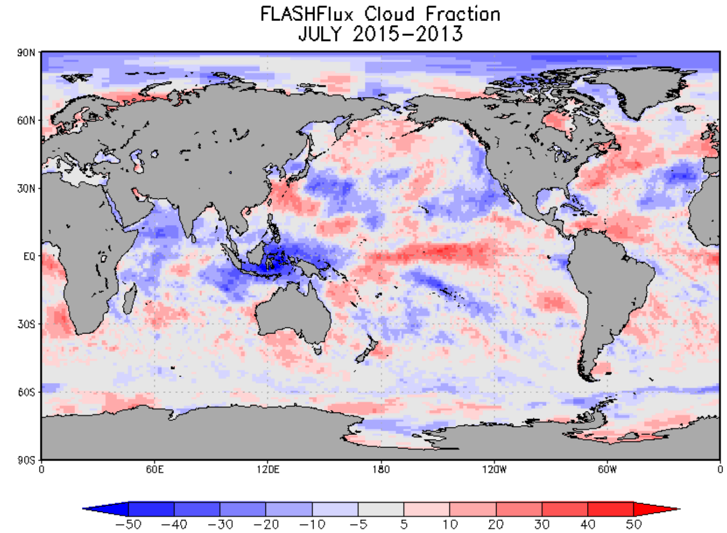


Fig. 2.34. Time series of global-monthly mean deseasonalized anomalies (W m^{-2}) of TOA Earth radiation budget for (top) OLR, (middle) absorbed shortwave (TSI–RSW), and (lower) total net (TSI–RSW–OLR) from Mar 2000 to Dec 2014. Anomalies are relative to the calendar month climatology derived for 2001–13. The time series shows the CERES EBAF Ed2.8 1Deg data (Mar 2000–Oct 2014) in red and the CERES FLASHFlux version 3B data (Nov–Dec 2014) in blue; see text for merging procedure. (Source: CERES EBAF Ed2.8 1Deg and the FLASHFlux version 3B.)

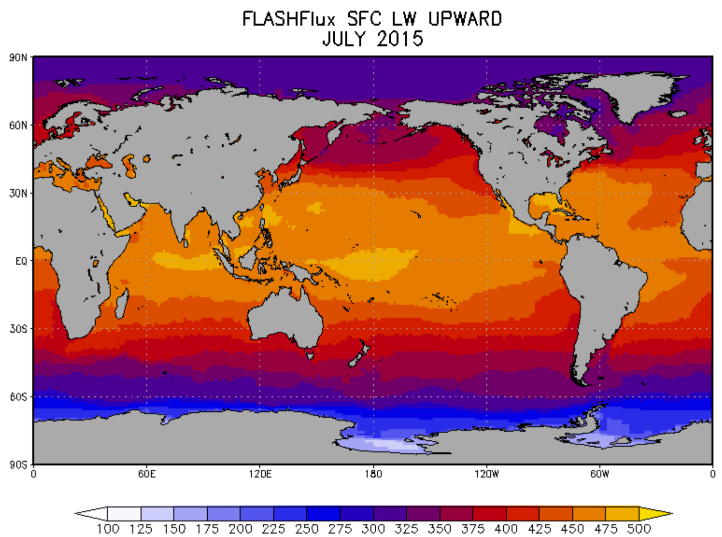
Cloud and Up LW Differences July 2015 - 2013

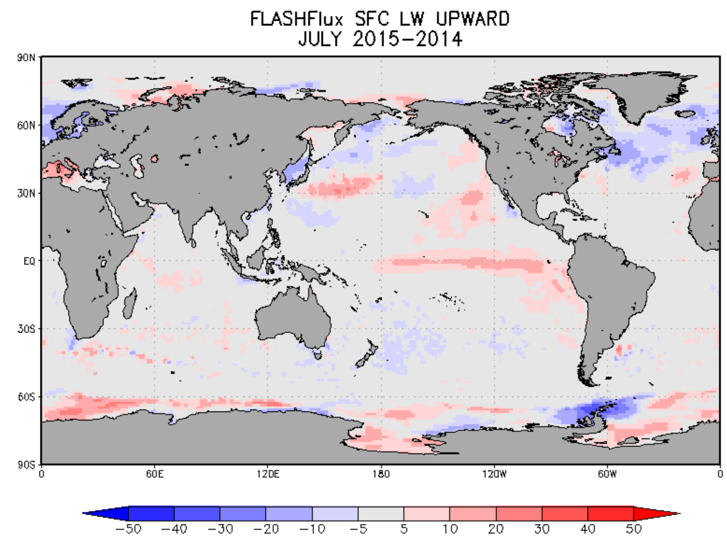
Cloud





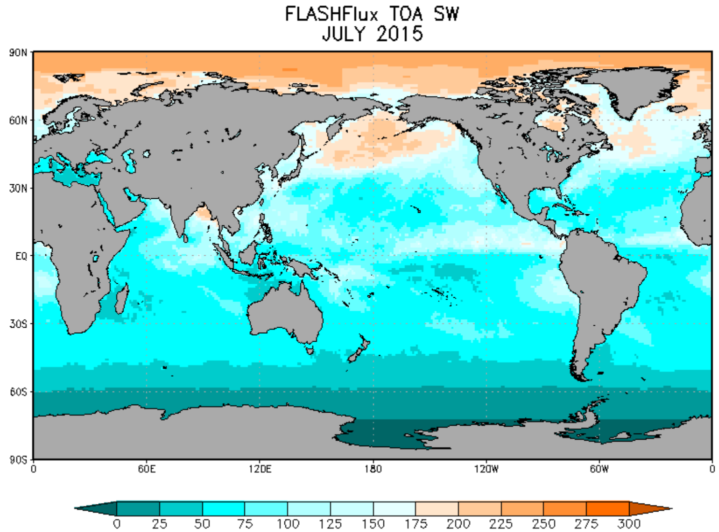
Surface LW UP

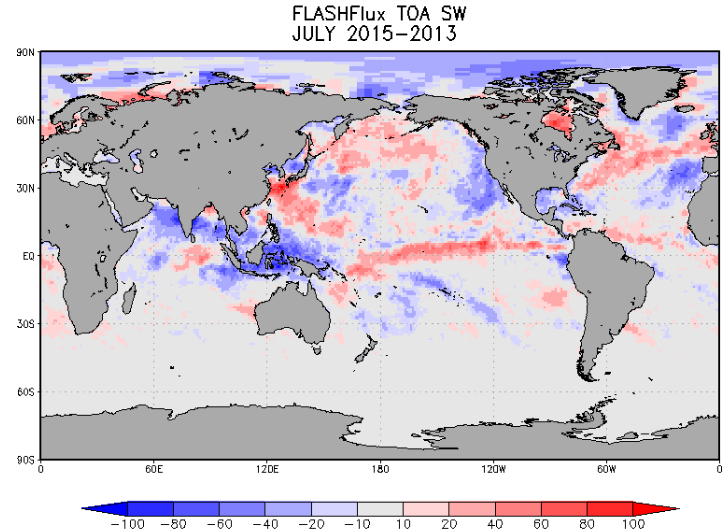




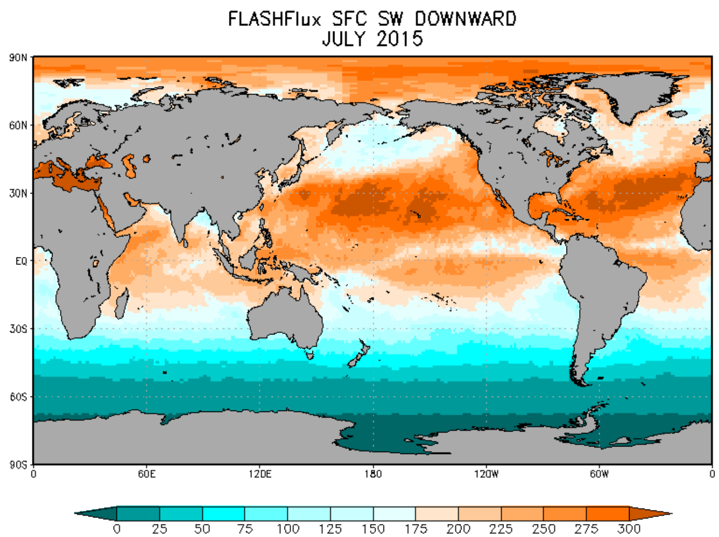
SW Differences July 2015 - 2013

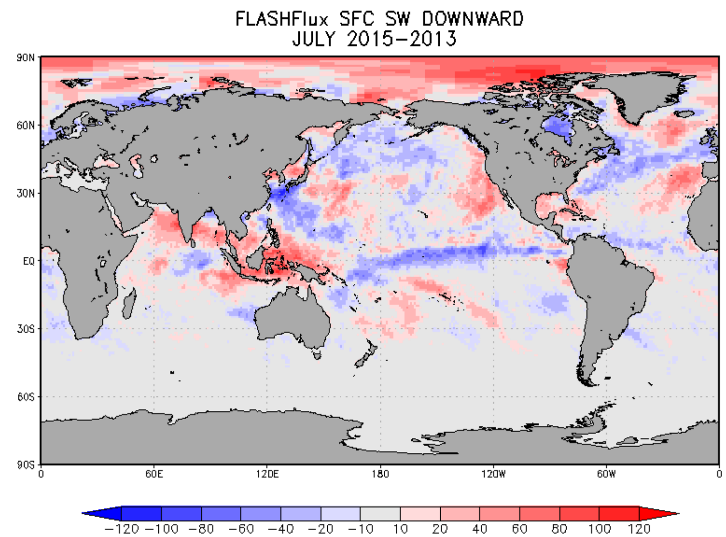
TOA Up





Surface Down

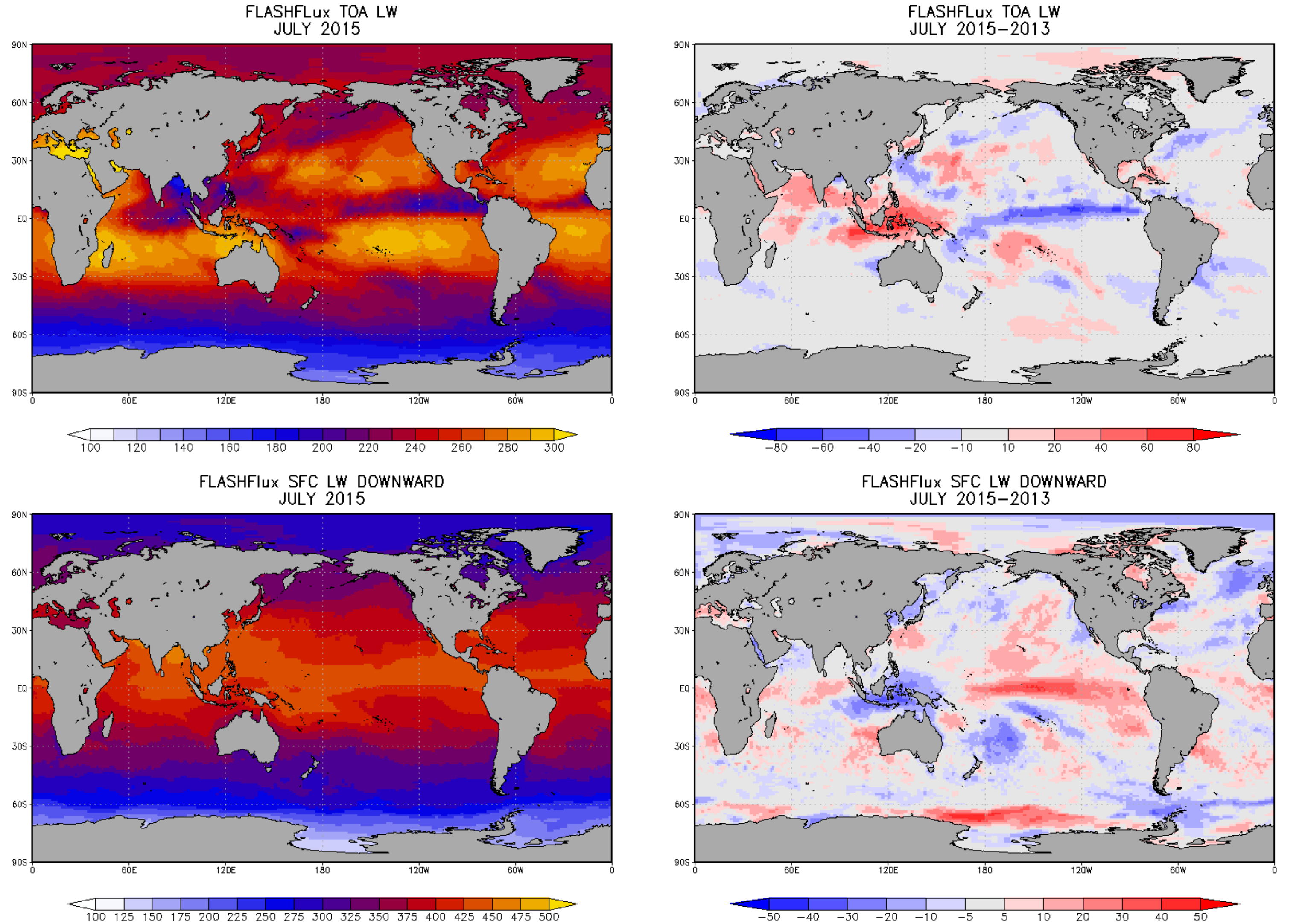




LW Differences July 2015 - 2013

TOA Up

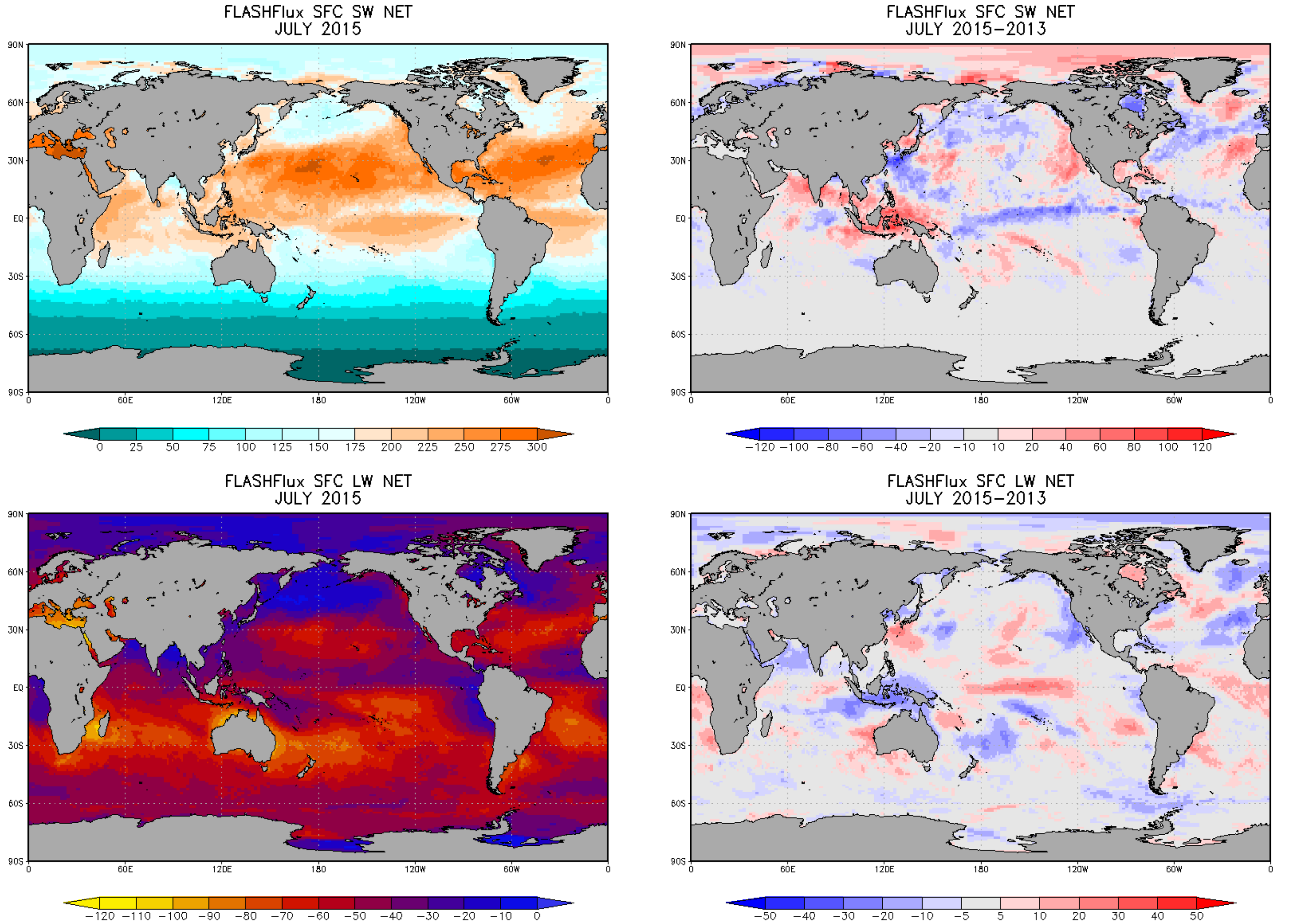
Surface Down



Surface Net Differences July 2015 - 2013

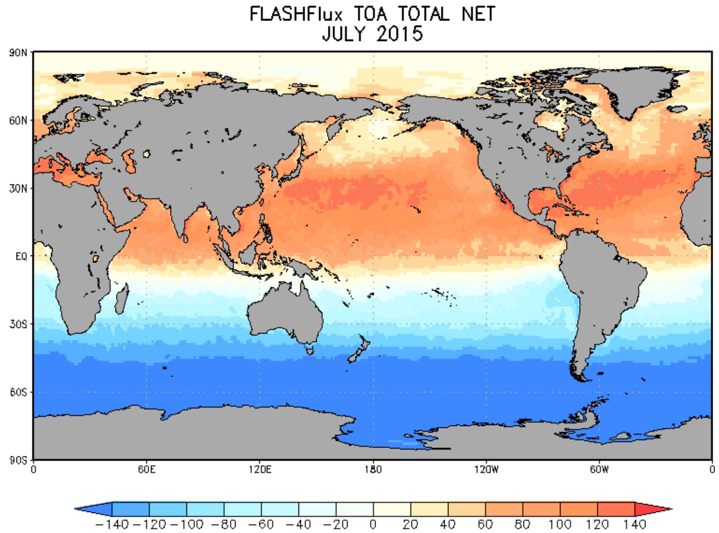
SW Surface Net

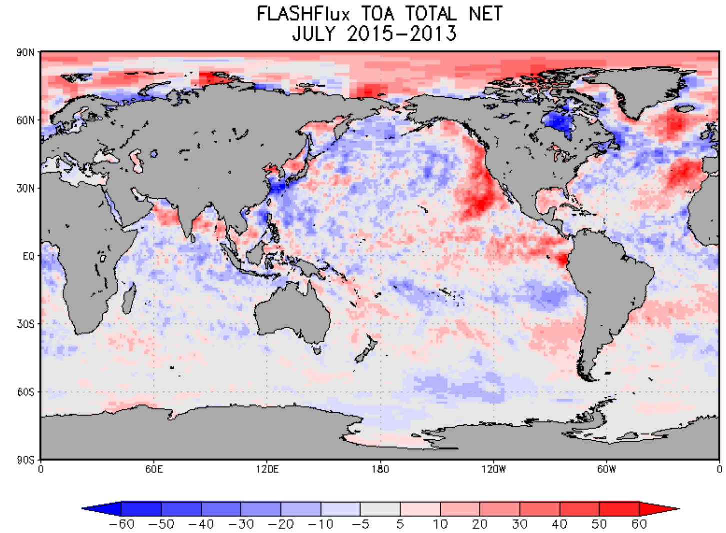
LW Surface Net



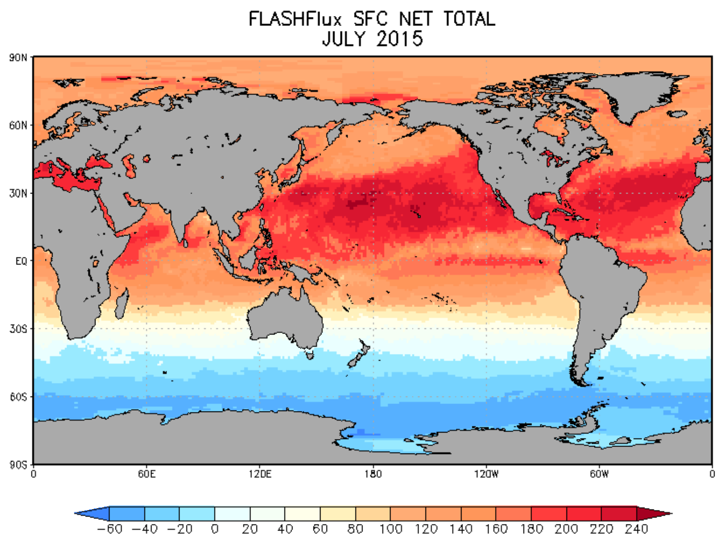
Total Net Differences July 2015 - 2013

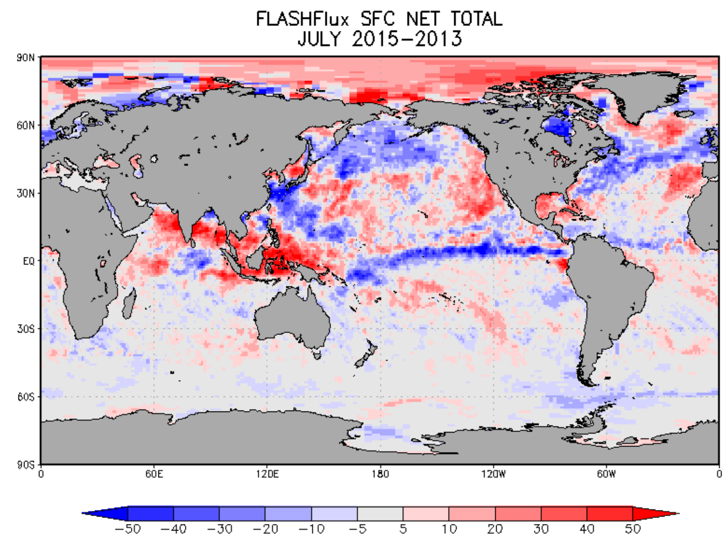
TOA



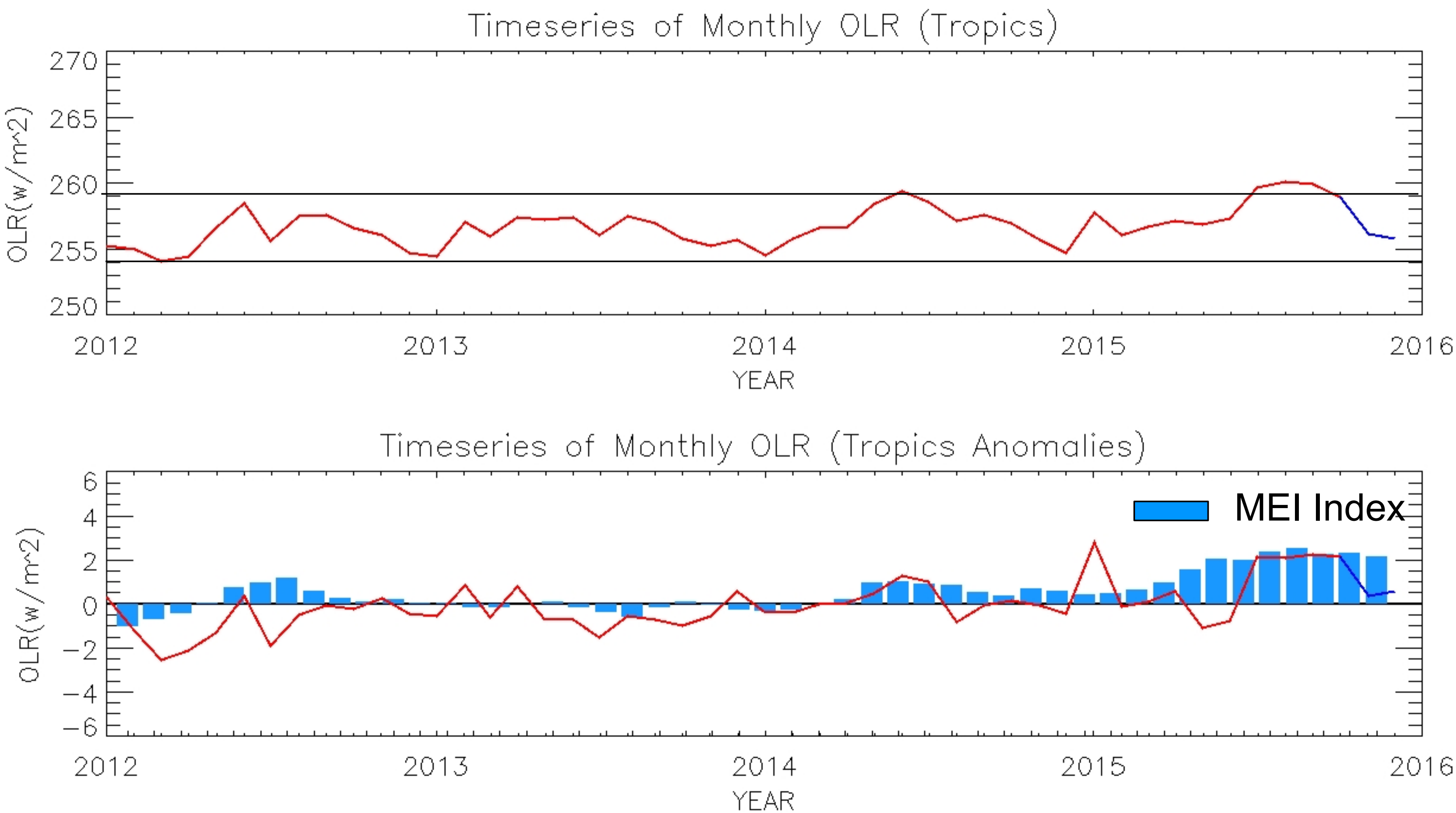


Surface





2015 Tropical Pacific Anomalies to Date
(20N-20S, 120E-100W)



2015 Tropical Pacific Anomalies to Date
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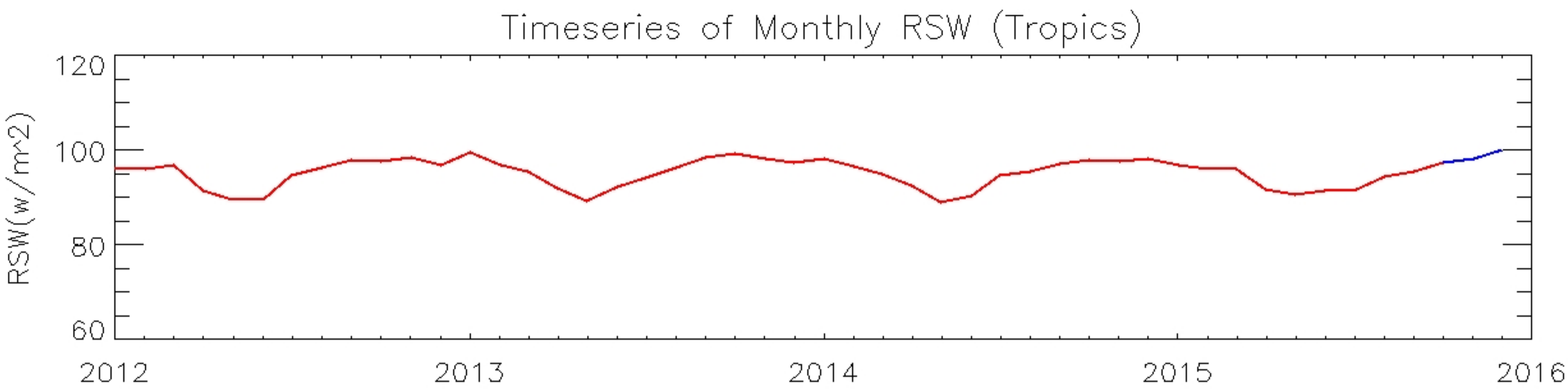

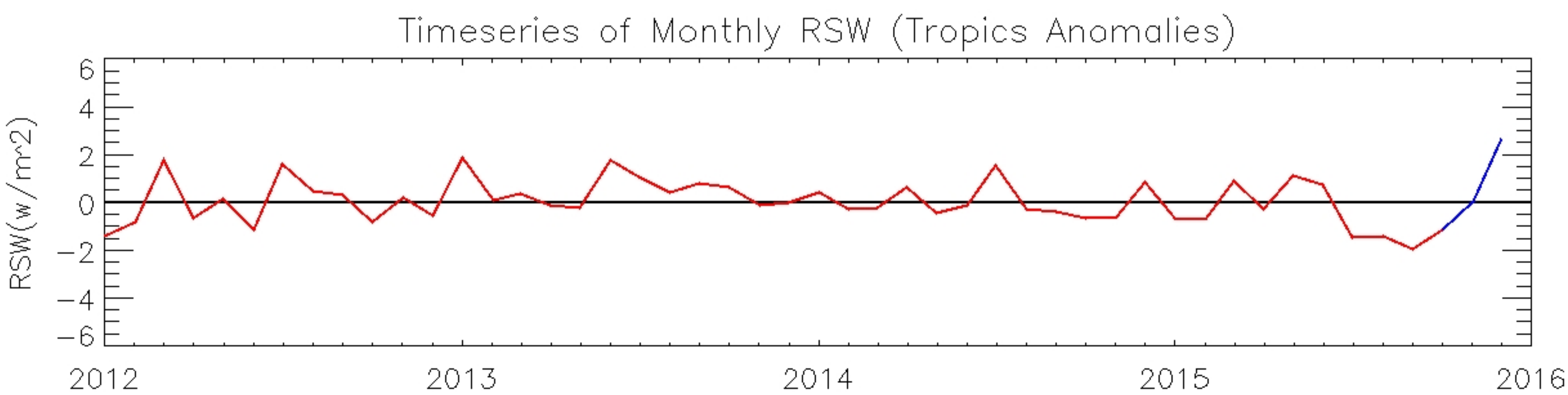

Enhancing Applied Science Usage with ArcGIS

ArcGIS Capabilities

- High quality viewing (Desktop/ Mobile) and printing
- Data Extraction/Subsetting => Python code to support a variety of data formats from ASCII, to .netCDF, to geoTIF
- Simultaneous Dataset Visualization (Swiping)
- Temporal Visualization (time slider)
- Custom Color Ramps
- Pixel/Attribute Value Identification at Selected Location
- Python code to support computation of on-the-fly parameter computation

Technologies

- Esri ArcGIS Server & Portal
- OPeNDAP
- PostgreSQL & PostGIS

Connectivity

- Climate.gov
- GEOSS (AIP-8)